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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/635,703	08/05/2003	David B. Glasco	NWISP036	8389
22434	7590	10/25/2004		
BEYER WEAVER & THOMAS LLP P.O. BOX 778 BERKELEY, CA 94704-0778			EXAMINER THOMAS, SHANE M	
			ART UNIT	PAPER NUMBER

2186

DATE MAILED: 10/25/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

## Office Action Summary

**Application No.**

10/635,703

**Applicant(s)**

GLASCO, DAVID B.

**Examiner**

Shane M Thomas

**Art Unit**

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

### Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

### Status

- 1) ☒ Responsive to communication(s) filed on 02 August 2003.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

### Disposition of Claims

- 4) ☒ Claim(s) 1-20 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-20 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

### Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 05 August 2003 is/are: a) ☐ accepted or b) ☒ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

### Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some \* c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
  2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
  3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\* See the attached detailed Office action for a list of the certified copies not received.

### Attachment(s)

- |  |   |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) *                      | 4) <input type="checkbox"/> Interview Summary (PTO-413)                     |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948)               | Paper No(s)/Mail Date. _____  |
| 3) <input checked="" type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| Paper No(s)/Mail Date <u>17 October 2003</u> .   | 6) <input type="checkbox"/> Other: _____                                    |

## **DETAILED ACTION**

This action is in response to application 10/635,703 filed 5 August 2003.

Claims 1-20 have been examined.

### ***Drawings***

The drawings are objected to because figures 10-15 seem to be misplaced in the application. Please remit the drawing sheets comprising figures 10-15. Corrected drawing sheets in compliance with 37 CFR 1.121(d) are required in reply to the Office action to avoid abandonment of the application. Any amended replacement drawing sheet should include all of the figures appearing on the immediate prior version of the sheet, even if only one figure is being amended. The figure or figure number of an amended drawing should not be labeled as "amended." If a drawing figure is to be canceled, the appropriate figure must be removed from the replacement sheet, and where necessary, the remaining figures must be renumbered and appropriate changes made to the brief description of the several views of the drawings for consistency. Additional replacement sheets may be necessary to show the renumbering of the remaining figures. The replacement sheet(s) should be labeled "Replacement Sheet" in the page header (as per 37 CFR 1.84(c)) so as not to obstruct any portion of the drawing figures. If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

### *Specification*

As written, claim 20 invokes **35 U.S.C. 112, sixth paragraph**. If the Applicant does not wish the claim limitation to be subject to this provision, claim 20 should be rephrased accordingly.

### *Claim Rejections - 35 USC § 102*

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

Claims 1-7, 11-17, and 20 are rejected under 35 U.S.C. 102(e) as being anticipated by Hum et al. (U.S. Patent Application Publication No. 2004/0123047).

As per claims 1, 11, and 20, Hum teaches a method for providing a response to a cache access request in figures 4 and 6. Further, Hum shows a *processing cluster* 110 in figure 1. Figure 4 shows the receiving of a cache access request [that is associated with a memory line] at a cache coherence controller (agent 120, figure 1). The cache coherence controller 120 represents multiple nodes, and cluster interface 210 (figure 2) provides two-way communication between the agent 120 and the set of nodes (§76). Since Hum states that an agent represents multiple nodes (§76), that a node can be comprised of a single processor (§109), and that the cache coherency system of the present invention is scalable (§71), the Examiner is considering elements 112-118 to be simple nodes (comprised of a single processor). Thus *cluster* 110

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comprises cache coherence controller 120 and processor nodes 112-118. The processors of cluster 110 are interconnected in a point-to-point architecture through agent 120 (refer to ¶¶ 55, 57 and 76). Response information for the cache access can be obtained from remote data cache 250 (import data cache) in accordance to figure 4 or can be obtained from remote data cache 260 (export directory) in accordance to figure 6. Since figure 2 is a representation of an agent (cache coherence controller) it can be seen that remote data caches 250 and 260 are associated with a given agent. In accordance with figure 4, the agent provides response information (step 450) to the requesting node (processor). While not specifically mentioned in figure 4, a completion response is sent along with the response information to the requesting node (processor). The Examiner is considering the ACK message (¶44) to be a --completion response-- since it indicates that the requested data has been sent to the requesting node (processor). While ¶42 states that the ACK message can be sent from the home node to the peer node, the Examiner is considering the cache coherence controller 120 to act as the --home node--, or owner of the data, when the cache coherence controller 120 fulfills a data request since the agent 120 can be considered a node (representing its cluster of nodes - ¶63) and, therefore, must follow the cache coherence process of the system (¶¶21- 46).

As per claims 2 and 12, the Examiner is considering the data response message from the agent 120 (cache coherence controller) that is sent to a requesting node (processor) to be a --response packet-- that comprises the requested data and the state of the data (M/E/F/S) to be used by the requesting processor (¶43).

As per claims 3 and 13, Hum teaches in ¶43 that in the cache coherency system of the present invention, state information (M/E/F/S) is included in the response information.

As per claims 4 and 14, as stated above, data is sent as part of the response information. Refer to ¶43 and figure 4, step 450.

As per claims 5 and 15, the Examiner is considering the ACK message that is sent from the agent 120 to one of its requesting nodes (processors) after the requested data to inform the requesting processor that that data response will be the *only response* to the data request since all data sent and received to a given processor (node) cluster of processors (nodes) is routed through the cluster's agent 120 (refer to figures 1, 2, 3 and 5 and ¶64). Thus it can be seen that the only response to a data request, will be sent to the requesting processor its cache coherence controller (agent); thus, the reception of the --completion indicator-- (ACK message) indicates to the requesting processor that it will be the only response to the request. It follows, that since the request from the processor is satisfied, by the definition of the ACK message, another response will not be needed to be sent to the requesting processor.

As per claims 6 and 16, the Examiner is considering the node (processor) requesting the data to be a --requesting processor-- (for instance processor 112, figure 2), and the requesting processor's cluster (cluster 110) to be a --requesting cluster-- since the cluster comprised the processor from which a request for data initiated.

As per claims 7 and 17, as shown in figure 4, if the requested data is in the import cache (remote data cache) of the cache coherence controller, the data is forwarded to the requesting node (step 450). Only if the request misses in the remote data cache will the cache coherence controller (120) send the request to the nodes that are represented by the cluster (step 445). Thus, it can be seen that the ACK signal (completion indicator) that is sent by the cache coherence controller in step 450 allows the cache coherence controller from having to probe

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local nodes (step 445) or remote nodes (nodes connected to other branches of agent 190, for example).

Claims 1-7, 11-17, and 20, are rejected under 35 U.S.C. 102(e) as being anticipated by Webb, Jr. et al. (U.S. Patent No. 6,751,721), herein Webb.

As per claims 1, 11, and 20, Webb teaches receiving a cache access request that is associated with a memory line at a cache coherence controller (directory processor 510, figure 5) from a requesting processor 500 in a cluster of processors 530. This access request is for exclusive ownership of the memory line in order to modify the line (column 5, line 62 - column 6, line 30). As shown in figure 5, the processors of cluster 530 are interconnected in a point-to-point architecture. Response information (data response from the directory processor containing the number of invalid responses that need to be received by the requesting processor before modifying the cache line) for the cache access request is received from a remote data cache associated with the directory processor 510 (cache coherence controller). The Examiner is considering the cache of the directory processor to be a remote data cache since it contains a share mask, which is responsible for maintaining the number of shared copies of a particular cache line (column 6, lines 9-21). The Examiner is considering the --completion indicator-- to be the number of invalid messages from processors containing the request shared data line. Thus, in order to complete the modification of the cache line, the requesting processor 500 must receive a certain amount of invalidate acknowledgements.

As per claims 2 and 12, the Examiner is considering the response to the requesting processor 500 from the directory processor 510 (cache coherence controller) containing the

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number of invalidate acknowledgements to be a response --packet--, data that is transferred from processor to processor.

As per claims 3 and 13, the --completion indicator-- indicated --state-- information in that it informs the requesting processor of how many *shared* cache copies exist in a system (such as figure 3).

As per claims 4 and 14, the Examiner is considering a number value to be --data--.

Therefore, since the --completion indicator-- contains the number of invalidate acknowledgements to be received before modifying a requested cache line, the response information sent from the directory processor (cache coherence controller) to the requesting processor contains --data--. Refer to column 6, lines 19-21.

As per claims 5 and 15, since the only response from the directory processor (cache coherence controller) to the requesting processor is the number of current shared copies of the cache line that are currently shared in the system, the requesting processor inherently knows (As part of the system protocol) that the --completion indicator-- informs the requesting processor that it will be the *only response* from the cache coherence controller (directory processor).

As per claims 6 and 16, the Examiner is considering the cluster 300 of figure 3 to be a request cluster since it contains the processor requesting exclusive access to a memory line. As can be seen, the processor 310 is a --requesting processor--.

As per claims 7 and 17, Webb teaches in figure 5 that the cache coherence controller (directory processor 510) and requesting processor 500 can be contained within the same node 530, and therefore, does not have to probe local nodes (nodes that are connected adjacently to



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node 530 - such as the two nodes directly connected to node 300 in figure 3) or remote nodes (the remainder of the nodes in the system that are not directly connected to node 530).

***Claim Rejections - 35 USC § 103***

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Claims 8-10, 18 and 19 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hum et al. (U.S. Patent Application Publication No. 2004/0123047), as applied to claims 1-7, 11-17, and 20, above, in view of Keller (U.S. Patent No. 6,728,841).

As per claims 8 and 18, Hum does not specifically teach the [requesting] processor sending a --source done-- upon identifying the completion indicator in the response from the cache coherency controller. Keller teaches in column 2, line 63 - column 3, line 11, that a step of sending a --source done-- upon receiving a response packet (including requested data) from a target node. The source done response allows the target node to remove the request for data from its command queue and can proceed to process the next request for the memory location. As evidenced by Keller, the sending of the acknowledgement (source done) from the source node back to the target node allows a cache coherent multiprocessor system to process memory read requests effectively. Therefore, it would have been obvious to one having ordinary skill in the art at the time the invention was made to have combined the cache response method of Hum

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with the messaging response teaching of Keller in order to have effectively maintained cache-coherence during memory reads in the multiprocessing system of Hum (figure 1 for instance). It would have been seen by one having ordinary skill in the art that once the requesting node of modified Hum (source node of Keller) received the read response (containing requested data) followed by an ACK message (completion indicator) from the remote data cache (import cache 250) of the cache coherence controller (agent 120), the requesting processor (node) would have sent a --source done-- response back to the cache coherence controller so that the cache coherence controller could have removed the read request from its command queue and to proceed to grant the subsequent next read request.

As per claims 9 and 19, as discussed in the rejection for claims 8 and 18, the --source done-- message is sent to the cache coherence controller (agent 120).

As per claim 10, as discussed in the rejection for claims 8 and 18, the --source done-- response is sent back to the cache coherence controller (agent 120). The Examiner is considering the cache coherence controller to be --acting as a memory controller-- since it controls the read requests send to a node in its local cluster and can forward the data back to the requesting node without having to send the request to the target node (processor). Refer to ¶63.

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Claims 8-10, 18 and 19 are rejected under 35 U.S.C. 103(a) as being unpatentable over Webb, Jr. et al. (U.S. Patent No. 6,751,721), as applied to claims 1-7, 11-17, and 20, above.

As per claims 8 and 18, Webb does not specifically show the requesting processor sending a --source done-- message upon receiving the --completion indicator-- (number of invalidations) in the response from the directory processor (cache coherency controller). However Webb does state that the directory processor maintains a share mask register for each cache line with bits indicating existing shared copies (column 6, lines 9-19). Since the invalidation acknowledgement are sent directly to the requesting processor rather than to the directory processor (column 6, lines 31-44), it would have been obvious to one having ordinary skill in the art at the time the invention of Webb was made to have modified the invalidation system of Webb to have sent a --source done-- response back to the directory processor (cache coherency controller) after the requested cache line was modified by the requesting processor (after receiving all the invalidation ACKs) in order to have informed the directory processor to change the share mask of the corresponding cache line to indicate the cache line has been modified by the requesting processor and is no longer being shared. In other words, the bit of the corresponding shard mask would all be inactive. It follows that the --source done-- would have occurred *after* the completion indicator - number of required invalidation ACKs - since the requesting processor can only modify the cache line *after* receiving the correct number of invalidation ACKs (column 6, lines 27-30). Such a modification to Webb would have maintained cache coherence in the system by assuring that incorrect sharing information would not have been registered in the share mask of the directory processor.

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As per claims 9 and 19, as discussed in the rejection of claims 8 and 18, the --source done-- message would have been sent to the cache coherence controller (directory processor) since the cache coherence controller maintains the share mask information that becomes updated when a cacheline is no longer shared.

As per claim 10, as discussed in the rejection of claims 8,9,18, and 19 above, the --source done-- message would have been sent back to the cache coherence controller (directory processor). The Examiner is considering the cache coherency controller to be --acting as a memory controller-- since it owns [and is responsible for maintaining share mask information for] the memory line (cacheline) that is being requested. Since it can be seen that the cache coherence controller *controls the memory* of the cache line, the cache coherence controller --acts-- like a memory controller.

### ***Conclusion***

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Edirisooriya et al. (U.S. Patent Application Publication No. 2004/0111566) teaches a point-to-point multi-processor system in figure 5 which allows for the eviction of a dirty cache line from one processor to an available replacement block of another processor.

Hass (U.S. Patent Application Publication No. 2003/0120876) teaches using a global snoop controller to facilitate snooping activity amongst point-to-point connected processors in a cluster.

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Pong (U.S. Patent Application Publication No. 2002/0053004) teaches the benefits of a point-to-point interconnected multi-processor system in ¶37.

Weber (U.S. Patent Application Publication No. 2001/0013089) teaches a point-to-point interconnected processing node system with a sparse caching system accompanying each processing cluster.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Shane M Thomas whose telephone number is (571) 272-4188. The examiner can normally be reached M-F 8:30 - 5:30.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Matt M Kim can be reached on (571) 272-4182. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).



Shane M. Thomas

*MD*



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